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Imparting Liquid Barrier Characteristics on Bamboo Medical Garments

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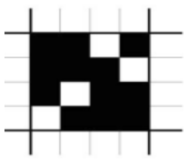
Abstract:- Hospital infection is by large bacterial or viral infection which develops during the patient stay at hospital or soon after leaving. The total statistical figure of patient in today's world acquiring infections during their hospital stay is frightening and one of the important reasons for that is lack of guaranteed barrier materials. Plasma treatments can answer the demand of textile industry. Besides the base function of dressing people, textiles contribute to human health and safety, protecting from exposure to dangerous environments. Important requirements for protective apparel are barrier effectiveness and comfort for the wearer. Bamboo species the advantage of bamboo as a raw material include its fast renewability, its biodegradability and its organic status. The advantages of bamboo fabric are its antimicrobial properties, better moisture management and anti-static properties. These advantages make bamboo an ideal choice for application in medical textiles compared to other fibres. Bamboo woven fabric treated with fluorocarbon finish by padding mangle method and then it undergone to a Low pressure plasma treatment process by with SF_6 gas, from that super hydrophobic features are readily achieved on the fabric. Barrier effectiveness with comfort, antimicrobial, sterilizing effect is moving towards high value added product segments in medical garments. E.g. Patient wear, surgical wear, hospital workers wear etc.

I. INTRODUCTION

One of the latest developments in new fibre researches is the use of bamboo fibre in various textile products that has been used in construction materials, decorating items, furniture and high performance composite materials for years. Regenerated bamboo fibre is obtained from the bamboo plant, which is an abundant and cheap natural resource. Bamboo grows in tropical climates and is harvested after 3 - 4 years Textile materials subjected to plasma treatments undergo major chemical and physical transformations including (i) chemical changes in surface layers, (ii) changes in surface layer structure, and (iii) changes in physical properties of surface layers. Plasmas create a high density of free radicals by disassociating molecules through electron collisions and photochemical processes. This causes disruption of the chemical bonds in the fibre polymer surface which results in formation of new chemical species. Both the surface chemistry and surface topography are affected and the specific surface area of fibres is significantly increased. Plasma treatment on fibre and polymer surfaces results in the formation of new functional groups such as —OH, —C=O, —COOH which affect fabric wettability as well as facilitate graft polymerisation which, in turn, improve or decrease the liquid repellence of treated textiles and nonwovens.

II. MATERIAL PREPARATION

Materials: 100% Bamboo yarn fabricated using Model Rapier Weaving machine, the construction detail of fabric is
Ends/inch = 130
Picks/inch = 64
Warp Count = 30s
Weft Count = 30s
Weave = 4 End Random satin



After scouring, bleaching, the fabric under gone for Low pressure plasma treatment with SF_6 gas after the application of fluorocarbon finish ***by*** padding mangle method, a vacuum vessel is pumped down to a pressure in the range of 10^{-2} to 10^{-3} mbar with the use of high vacuum pumps. The gas which is then introduced in the vessel is ionized with the help of a high frequency generator.

Application of Fluorocarbon Finish by Padding Mangle Method Recipe:**-**
Resi Guard WOR 581 -70 gpl
VLFR - 40 gpl

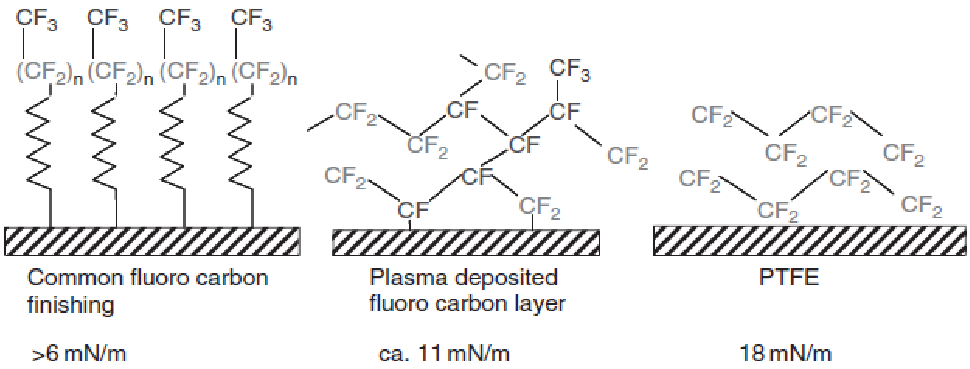
Mgcl2 - 8 gpl
R75 cone - 20 gpl
PH - 4.5 - 5.0
Dry - 120^{o} C to 130^{o} C (90 minutes)
Curing - 160^{o} C (3 to 5 minutes)

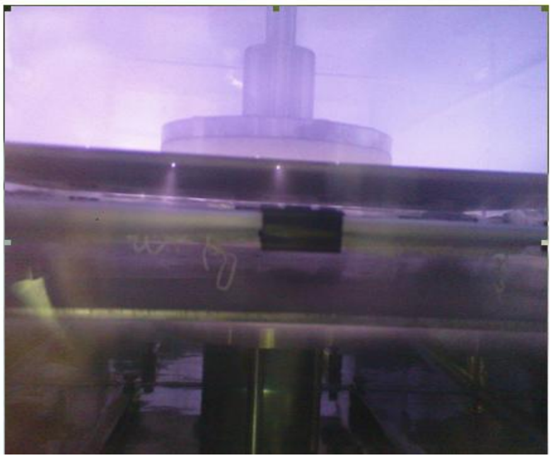
III. HYDROPHOBIC AND OLEOPHOBIC TREATMENT BY PLASMA

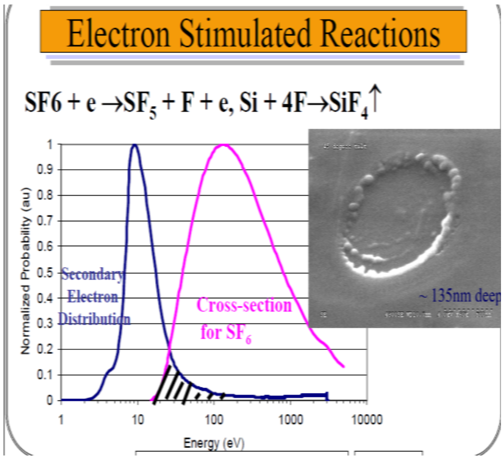
The generation of water and oil repellent functional layers on textiles by plasma polymerisation of fluorocarbons at atmospheric pressure under continuous in line conditions has been a major issue in collaborative research projects at ITV Denkendorf.

The structures of plasma polymerised fluorocarbon coatings are characterized by a relatively high degrees of cross-linking, which can be deduced from CF-group detection by XPS-analysis. The molecular structures and specific chemical functionalities of the used gaseous precursors are only rudimentarily found in the cross-linked deposited layer.

The surface energies strongly depend on the density of CF3-groups at the fluorocarbon surfaces. Schematic structure models of common fluorocarbon textile finishing's, PTFE and plasma polymerised fluorocarbons is illustrate in the Figure







A vacuum vessel is pumped down to a pressure in the range of 10^{-2} to 10^{-3} mbar with the use of high vacuum pumps. The SF_6 gas which is then introduced in the vessel is ionised with the help of a high frequency generator. The advantage of the low-pressure plasma method is that it is a well controlled and reproducible technique.

Modes of action:

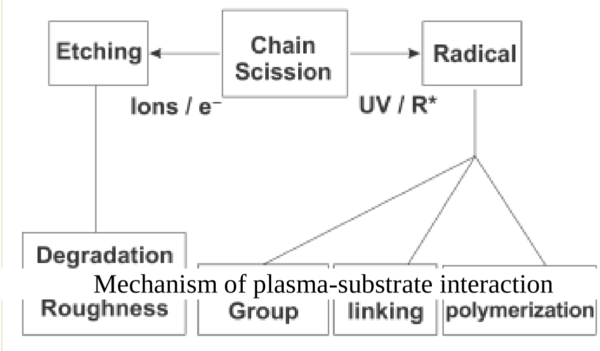
When a surface is exposed to plasma a mutual interaction between the gas and the substrate takes place. The surface of the substrate is bombarded with ions, electrons, radicals, neutrals and UV radiation from the plasma while volatile components from the surface contaminate the plasma and become a part of it. Whatever may be the final outcome on the surface, the basic effect that causes modification is based on the following phenomena.

A. Radical Formation

i. Attachment of functional group
ii. Deposition/polymerization

B. Etching

It is through the use of these in different combinations and on different substrate that the vast variety of outcomes which are possible through plasma treatment can be achieved. Figure illustrates the mechanism of plasma modification as discussed.



Mechanism of plasma-substrate interaction

PLASMA STERILIZATION MECHANICS / IONIZING RADIATION (IR) VOLATILIZATION:-

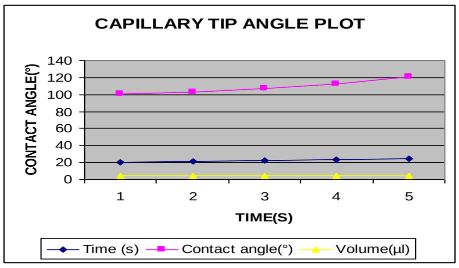
- IR is able to vaporize microbiological matter, causing physical destruction of spores.
- Charged particles react with cellular chemical bonds of microbiological layer to form gaseous compounds → volatile compounds.
- IR (UV/VUV radiation) can damage DNA/RNA, chemical cellular bonds, and induces free radicals to perpetuate the process
- Damaged DNA/RNA → microbial death by 4 mechanisms:

1. Apoptosis – nucleases become hardwired to shrink and cause cell to commit suicide. Caused by DNA/RNA damage
2. Autophagy – Formation of double membrane vacuoles in cytoplasm → separation of mitochondria and ribosome's → protein production stopped → cell death
3. Necrosis – Murder by cell swelling
4. Mitotic Catastrophe – radiation causes mis-segregation of chromosomes, leading to Apoptosis

IV. RESULTS AND DISCUSSION

Time (s)	Contact angle(°)	Volume(µl)
20	100.45	3.987
21	102.35	4.145
22	107.36	4.328
23	112.68	4.258
24	120.74	4.078

Table1: Contact angle Measurements



Sample	Before Plasma treatment (gm/mtr sqr/day)	After Plasma treatment (gm/mtr sqr/day)
1	2810	2849
2	2800	2850
3	2820	2865
4	2814	2868
5	2827	2872

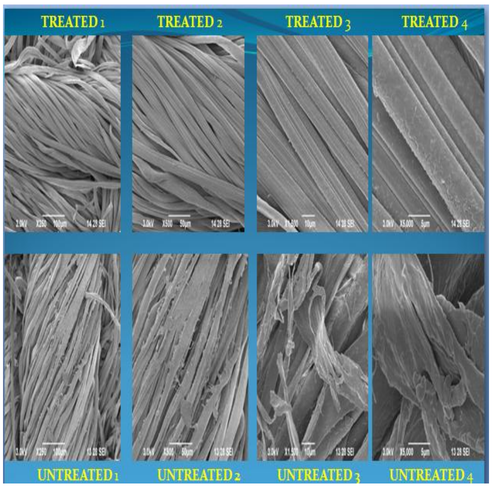
Table 2 : Water vapour transmission ratio **ASTM BS 7209**

Sample	Before plasma treatment (ltr/min)	After plasma treatment (ltr/min)
1	**40.3**	**41.8**
2	**41.2**	**42.7**
3	**39.9**	**41.02**
4	**40.6**	**41.5**
5	**41.3**	**42.8**

Table 3 : Air permeability test **ASTM D737**

Sample No.	Sample particulars	Bacterial reduction (in %)		
		Staphylococcus (ATCC 6538)	Klebsiella pneumoniae (ATCC 4352)	Remarks
1	4 End Satin - 100% Bamboo (Plasma	86	75	Excellent antibacterial activity
2	4 End Satin - 100% Bamboo (Plasma	85	75	Excellent antibacterial activity
3	4 End Satin - 100% Bamboo (Plasma	87	76	Excellent antibacterial activity

Table 4: Anti Bacterial reduction test



- The water contact angle of fabrics increased from 0^o up to 122^o. The slippery angle is increased with respect to time in seconds which shows the super hydrophobic nature due to SF_6 plasma treatment.
- Water Vapour Transmission Ratio (ASTM BS 7209) and Air permeability test (ASTM D737) results shows slightly higher range of values before then the plasma treatment which indicates the itching action of plasma causes the porosity of the fabric improved.
- Assessment of Antibacterial Activity by Bacterial Reduction Test Staphylococcus (ATCC 6538) is 86% and Klebsiella pneumoniae (ATCC 4352) is 75% remarked as excellent antibacterial activity.

SEM Images of Treated (Fluorocarbon finish with SF_6) & Untreated

Here the Four SEM images were taken at micro meter level of 100µm, 50µm, 10µm, 5µm.Up to the 50µm level the treated fabric shows the result of crystallized arrangement of fibre (crystalline region repels liquid) compare to untreated amorphous structure of 100% Bamboo fabric. At the 5µm level, the picture shows the result of Surface Etching by the effect of SF_6 Plasma treatment.

Generally three Parameters considered for the effectiveness plasma process

1. Internal plasma parameters like, Geometric factors, power frequency, Gas composition, gas flow, pressure.
2. Consequences of plasma surface interaction like, surface potential, surface temperature, fabric structure (satin/sateen preferred).
3. Effectiveness of Sterilization depends upon composition of fibre and its blends, presence of organic residues or salts, Nature and surface density of microorganisms.

V. CONCLUSION

Plasma technology is suitable to modify the chemical structure as well as the topography of the surface of the material. Examples of natural as well as man-made fibers prove the enormous potential of plasma treatment of textile materials. Not only had the chemical structure of the surface modified using different plasma gases but also the topography of the surface. A highly hydrophobic surface with a particular surface topography in contact with water is extremely resistant to bacteria and fungi. Hence the end fabric is utilized for medical garments which give protection from infections.

REFERENCES

[1]. Anand S C, Medical Textiles 96 (Woodhead Publishing Ltd Cambridge), 1997, pp.3-6.
[2]. American Convertors - ISO•BAC™ Literature, August 1980.
[3]. AORN Journal, Vol. 21, No. 4, March, 1975, p. 594.
[4]. Bhat, N.V., and Benjamin, Y.N. 1989, Indian J Text. Res. pp1-14.
[5]. Collier, B.J., Collier, J.R., Agarwal, P., and Lo,Y.W. 1992, Textile Research Journal, 62, pp.741.
[6]. Coulson S R, Brewer S A, Willis C R, Badyal J P S (1997), GB Pat.Patent: WO 98/58117.
[7]. Coulson S. R., Woodward I S, Badyal J P S, Brewer S A, Willis C R (2000), 'Plasma chemical functionalization of solid surfaces with low surface energy perfluorocarbon chains', Langmuir, 16, pp6287–6293.
[8]. Coulson S R, Woodward I S, Badyal J P S, Brewer
[9]. S A, Willis C R (2000) Super-repellent composite fl uoropolymer surfaces', J. Phys. Chem. B,104, pp8836–8840.
[10]. Coulson S R, Woodward I S, Badyal J P S, Brewer S A, Willis C R (2000) 'Ultra low surface energy plasma polymer fi lms', Chem. Mater., 104, pp2200-2241
[11]. Dai, X.J. and Kviz, L. 2001, "Study of atmospheric and low pressure plasma modification on the surface properties of synthetic and natural fibres", CSIRO.
[12]. Davidson et.al., Brit. J. of Surgery, Vol., 58, No. 5, May, 1971, pp 333-337.
[13]. Dow Corning Corporation, Corporate Test Method 0923, Dynamic Shake Flask Test.
[14]. Fibres & Textiles in Eastern Europe Jan/March 2008. Vol.16, No 1 (66), pp 99-102.
[15]. Kan C.W. Chan K., Yuen C.W.M., Fibres & Polymers 2004, 5(1), pp 52-58.
[16]. Kim M.S. Kang T.J., Textile Research Journal 2002, 72(2), pp 113-120.
[17]. Malek, James R. and J.L. Speier, J. Coated Fabrics, 12, 1982, p. 38.
[18]. Michel Moisan, Jean Barbeau, Marie-Charlotte Crevier, Jacques Pelletier, Nicolas Philip, and Bachir Saoudi 2002, Plasma sterilization. Methods and mechanisms Pure Appl. Chem., Vol. 74, No. 3, pp. 349–358.
[19]. Practical-perspectives, processing of bamboo fibre in textile industries. Colourage 2007, 54(4) pp.72
[20]. Rajendran S & Anand S C, Contribution of textiles to medical and healthcare products and developing innovative medical devices, Indian J Fibre Text Res , 31(1) (2006) pp215.
[21]. Thongphud. A, Paosawatyanyong. B, Visal-athaphand.P and. Supaphol .P 2008, Improvement of Hydrophobic Properties of the Electro spun PVA fabrics by SF6 Plasma Treatment, Advanced Materials Research Vols. 55-57 pp 625-628.